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XC90 Traction Control Systems
Interior Electrical Systems
No Start Problems, Part 1

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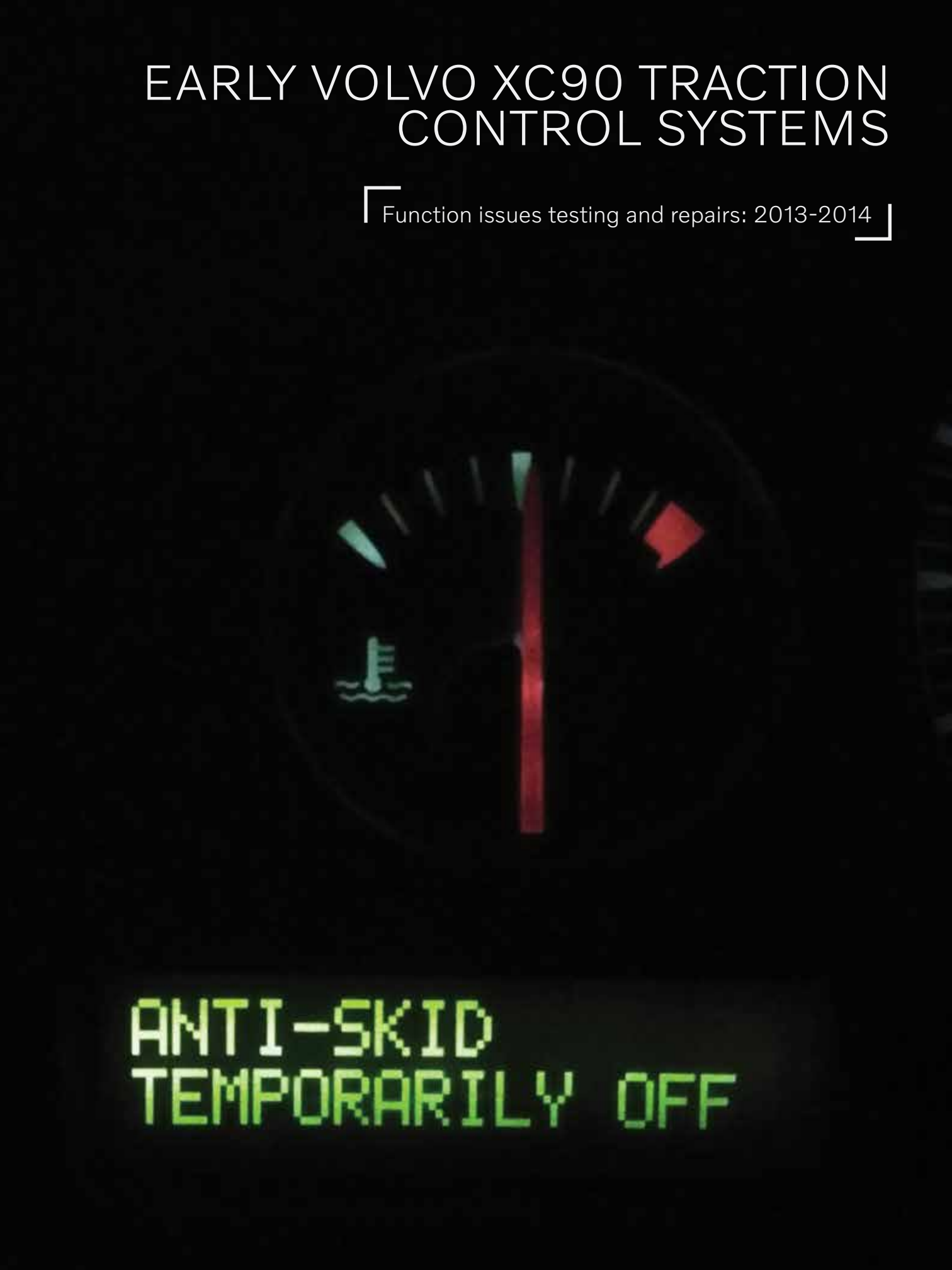
FEATURES

DEPARTMENTS

EARLY VOLVO XC90 TRACTION CONTROL SYSTEMS

Function issues testing and repairs: 2013-2014



The Volvo XC90 is more popular than it's ever been, not just with longtime Volvo fans, but with the rest of the world too. This is because the XC90 series, even from the beginning in 2003, was one of the best SUVs on the road. These SUVs can handle almost any on- or off-road conditions your customers can put them through.

Even the earliest XC90s came with one of the most comprehensive traction control systems on the road, and with every year since their inception, the systems have gotten better.

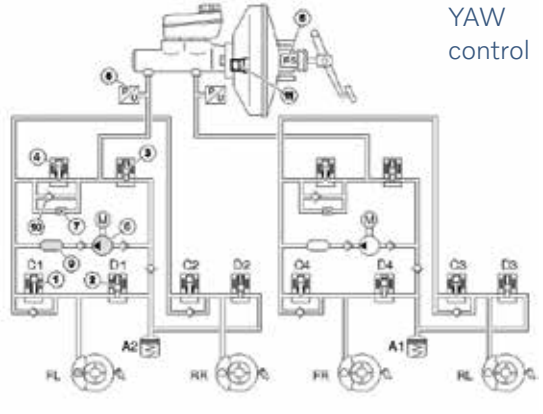
Of course, the newest generations of the XC90 (2016 on) are light years ahead of the early versions, but they have a lot in common with earlier models as well. And there are still a lot of the early XC90s on the road; you probably see a fair number of them come through your shop on any given week. They are getting older, and with age and mileage, you will start to see problems you have not seen before.

Customers love these cars, and most XC90 owners want to keep them going as long as possible. It's our job to make sure that these Volvos are as safe to drive as the day they rolled off the assembly line in Sweden.

How can we do that?

Well, one way is to help your customers by performing detailed routine inspections when they bring the cars in for regular service.

And when your customer reports a warning light or message in the information window, you need to take it seriously.



YAW control

Opposite Page: If your customer is getting a traction control message, even if only intermittently, it should be taken seriously because when the warning is illuminated, the car's traction control system is usually disabled.

These warning lights and messages don't just pop on and off for no reason.

If your customer gets a message that says something like "ANTI-SKID TEMPORARILY OFF" or "DTSC SPIN CONTROL OFF" it means just that — while that message is on, one of the major safety systems on that Volvo is not working.

It's important to educate your customer about the warning indicators and what they mean. You don't need to scare them, but they should know that continuing to drive the car in this condition can be risky in some road conditions, like wet weather and snow driving.

How it Works: Roll Stability Control (RSC)

The Volvo XC90 has an active system which counteracts any tendency to roll over and gives the vehicle added stability during abrupt avoidance maneuvers.

If there is a risk of the car turning over, RSC is activated. This function is integrated in the Dynamic Stability and Traction Control (DSTC) system. It lowers the engine torque and stabilizes the vehicle by braking at one or more wheels.

Active YAW Control

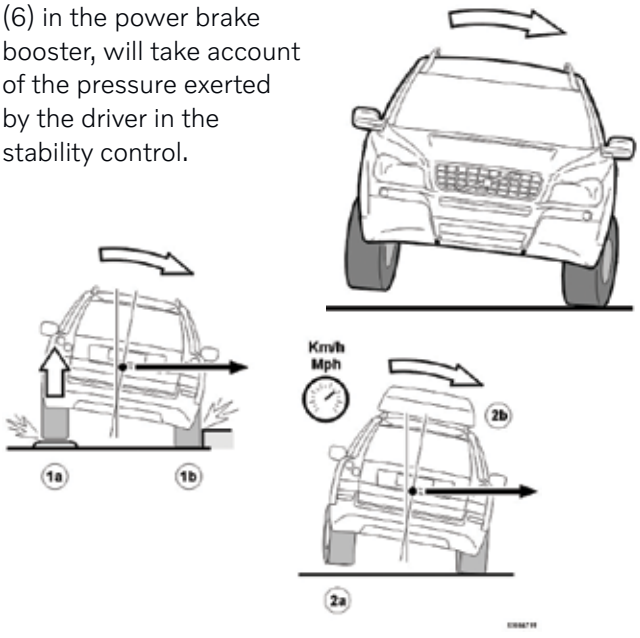
The Brake Control Module (BCM) with DSTC uses continuous information from the different sensors in the system to calculate the positions of the steering wheel and car. The BCM calculates the driving manner of the driver by measuring the steering wheel angle, the engine torque, the speed of the car and brake pressure. The BCM also calculates the behavior of the car by monitoring the steering wheel angle, steering wheel angle speed, yaw rate speed and lateral acceleration.

When the differences between the movements of the driver and the behavior of the car exceed a certain point, Active Yaw Control limits the engine torque to maintain lateral stability in all driving conditions. Active Yaw Control also activates the power brake booster and the individual brake control. This controls the hydraulic modulator separation valves and electronic shuttle valves, and the inlet and outlet valves, which correct the car in the event of a skid.

During Active Yaw Control, when the car skids, a vacuum valve opens on the power brake booster. The power brake booster then quickly builds up pressure without the driver activating the brake pedal. At the same time the hydraulic pump (8) starts and builds up brake pressure.

The hydraulic pump takes over braking after the initial phase. The BCM then activates the valves in the hydraulic modulator and checks the individual wheel brake forces by raising, maintaining, or lowering the pressure individually to stabilize the car. The brake pedal moves up and down during activation.

If the driver presses the brake pedal during stability control operation, the control module, through the pedal pressure sensor (6) in the power brake booster, will take account of the pressure exerted by the driver in the stability control.



Some of the more common traction control problems in the early XC90s are:

- Worn or broken wheel sensors
- Rusted or damaged teeth on the ABS sensor pulse wheels
- Resistance caused by corrosion in the traction control system wire connectors
- Worn or damaged steering wheel spiral cable
- In some cases, software updates not performed
- Calibration issues
- Malfunctioning CAN network module
- Short or open in CAN network wiring
- Worn or malfunctioning sensor
- And much more.

Volvo has issued multiple TSBs, or as Volvo calls them, Technical Journals (TJs), that have to do with traction control systems on the XC90.

One example is TJ 28031.

DSTC = Dynamic Stability and Traction Control

BCM = Brake Control Module

DESCRIPTION: Anti-skid warning lamp with

Code	Description
DY	Warning lights and chimes/Anti-spin/ Anti-skid (DSA, Tracs, STC, DSTC) indication/no indication
YP	Anti-lock brake system (ABS)/Does not work or engages unexpectedly
PA	Anti-spin function/Does not work
PJ	Stability function/Does not work

Control Module	Code	Fault Type
BCM	C006364	Intermittent
BCM	0121	Intermittent

DSTC warning message may be set after a few minutes of driving after system start-up, with DTC BCM-C006364 or BCM-0121.

The symptoms indicate that there could be a plausibility problem with the alignment of the Steering Angle Sensor (SAS) or a faulty wheel alignment. However, the DTC could present if both SAS alignment and wheel alignment are within specifications due to algorithm specifications in BCM software.

PRODUCT MODIFICATION: New BCM software was released in 2013 week 22 in production and is also available to upgrade existing vehicles from model year 2006.

SERVICE: Order and download BCM Upgrade software, PN 30677015.

XC90 Traction Control Components and Testing

1. Steering wheel angle sensor (spiral cable assembly)
2. Steering wheel Angle Sensor (SAS)
3. YAW rate sensor (AYC)
4. Wheel sensor, front
5. Wheel sensor, rear
6. Brake control module
7. Power brake booster
8. Brake fluid pressure sensor front
9. Brake fluid pressure sensor rear
10. Brake pedal position sensor
11. Traction control warning light
12. Dynamic Stability and Traction (DSTC) switch

Steering Angle Sensor (SAS)

The steering angle sensor, or contact reel, has multiple functions. Not only is it a sensor that tells the BCM

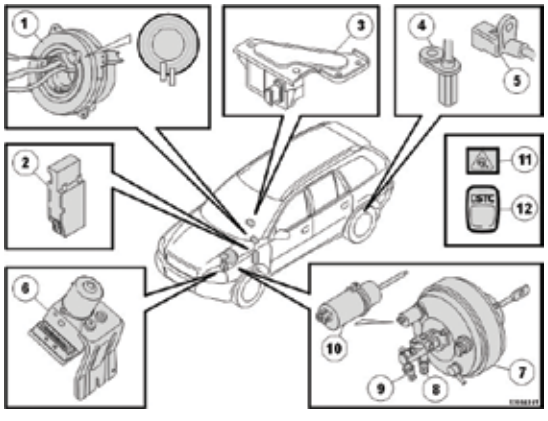
and CEM what angle the wheel is turned, it's also the only connection for all the electronics mounted in the steering wheel, including the driver's air bag.

The SAS is a module in the Control Area Network (CAN), so when it's replaced you will need to use VIDA to download new software so the car will recognize it.

In some cases, problems with the SAS module can be fixed with a software update. Here are a couple of things to check before replacing the steering angle sensor.

Is the car out of alignment?

If the car pulls to one side and the suspension checks out OK, start with a four wheel alignment. Most modern alignment machines have the capability to calibrate the steering angle sensor as part of the alignment.



Check the network with VIDA to see if the latest version of the SAS software is installed.

YAW Rate Sensor or Active YAW Control Sensor (AYC)

The active yaw rate sensor is one of the most important parts of the XC90's outstanding traction control system. This fairly delicate and complex sensor measures the vehicle's yaw, or angle of attack, in any driving condition.

The yaw sensor tells the traction control system the degree and direction of vehicle lean. The sensor also uses inputs from the wheel speed and steering angle sensors to calculate whether corrective action is needed to stabilize the vehicle.

The XC90's yaw sensor is one of the main reasons that it is very difficult for a driver to roll one of these cars.

The main reason these sensors fail is because of a build-up of corrosion in the connectors.

If you have to replace the yaw sensor, make sure to use a new Volvo Genuine Part, and be careful handling the part. If you drop it on a concrete floor, you may damage it enough to ruin it.

On the XC90, the yaw sensor is located under the right front seat under the amplifier module.

When you remove the amplifier module, take care to not damage the wire connectors. It is common for someone to not plug the connector with two orange fiber optic cables all the way into the amplifier, causing intermittent problems with the MOST network and infotainment system.

The YAW rate sensor on the XC90 is located under the amplifier module under the front passenger seat. When you need to replace this sensor, handle it carefully, as dropping it may damage a fairly expensive new part. The new YAW sensor will need to be calibrated with VIDA but will not require a software package.

ABS Sensors

Volvo ABS sensors are pretty rugged and don't usually fail even after many years of service. The problems with the sensors are more commonly due to rust or damage to the ABS sensor pulse wheels.

Broken, worn, or missing teeth are more common in areas that experience snowfall in the winter,

especially if salt is used on the roads. Of course, you will come across the occasional ABS sensor failure due to damage to the cable from running over something.

It's also common to have ABS sensor codes stored for front wheel sensors due to missing, loose, or broken axle bolts on the end of the outer CV shafts.

Brake Control Module (BCM)

It is extremely rare to have a late-style BCM malfunction. BCMs on post-1999 Volvos are rarely replaced, and the ones that are were probably due to a misdiagnosis.

Before you replace a BCM, check out Volvo's technical journal TJ -12913.

In most cases, BCM codes are caused by other parts of the traction control system malfunctioning. Most actual BCM issues can be fixed with the latest BCM software update.

Vacuum Brake Booster

You will see the occasional brake booster failure in higher mileage Volvos. They usually won't store trouble codes, except in rare cases you may get an ECM code P0171 for an unmetered intake air leak.

When vacuum brake boosters fail, you will usually hear a hissing sound from under the dash when the brake pedal is depressed.

Brake Fluid Pressure Sensors

Here is another Volvo part that is very reliable and that rarely is replaced.

The one problem you may see on older sensors is that fluid can work its way into the sensor and start to leak out into the connector. You may get a code stored in the BCM for a short to ground in the pressure sensor circuit. This can be especially true in brake fluid systems where the customer has failed to regularly flush and fill the brake fluid.

Brake Pedal Position Sensor

This sensor is mounted on the body of the vacuum brake pressure booster. It uses a piston to measure the position of the brake booster's bellows, telling the BCM the relative position of the brake pedal. These sensors are fairly easy to replace, and they do go bad from time to time.

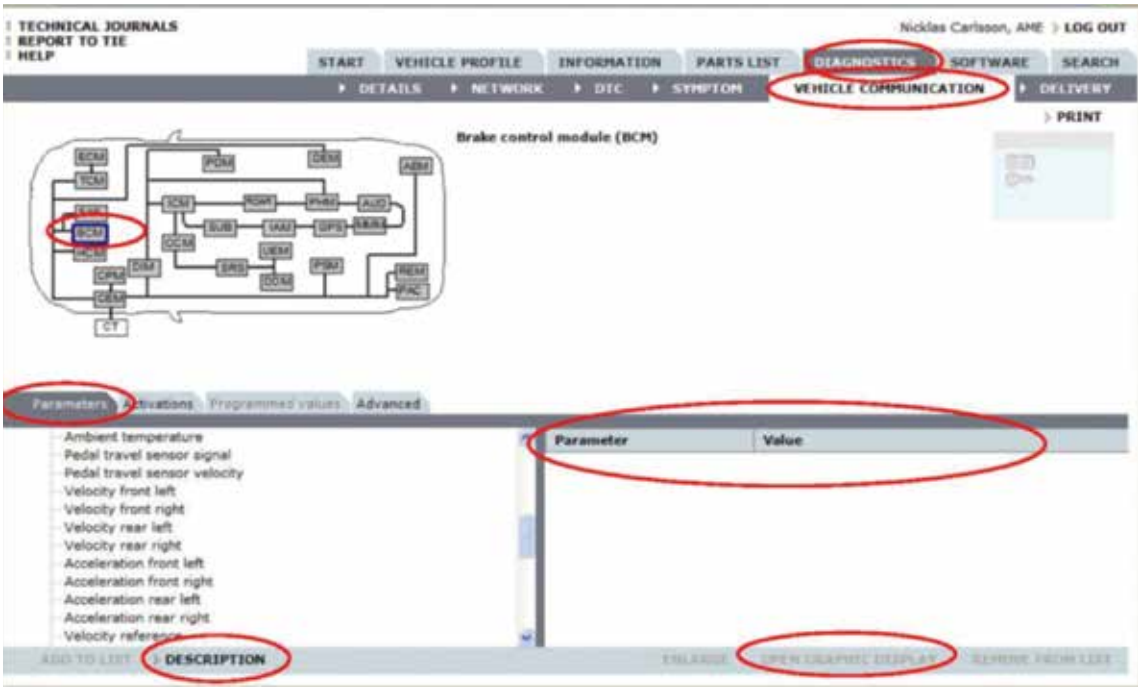
When you get the new sensor from Volvo, it will come with a new clip and sealing o-ring, so do not reuse the old o-ring. All you need is a pocket screwdriver or pick to compress the clip that holds it into the booster.

If you want to check out the brake pedal position sensor circuit, try the following.

Check the cables between:

- Pedal position sensor terminal #1 and brake control module terminal #7 (#A7)

Volvo's VIDA software is still the best tool to diagnose problems on Volvos. You can monitor and record up to ten parameters at one time and can use it to check the BCM data during a test drive to check the operation of the traction control.



- Pedal position sensor terminal #2 and brake control module terminal #5 (#A5)
- Pedal position sensor terminal #3 and brake control module terminal #3 (#A3)

Check for open circuit, short circuit to ground, and short circuit to voltage.

Hint: Connect an ohmmeter between terminals 2 and 3 on the pedal position sensor's connector. The resistance should be approximately 0.5 K ohms with the brake pedal inactivated and approximately 2.5-3 K ohms with depressed brake pedal.

Connect the ohmmeter between #1 and #3 on the pedal position sensor's connector. The resistance should be approximately 2.5-3 K ohms with the brake pedal inactivated and approximately 0.5 K ohms with depressed brake pedal. If resistance is incorrect, replace the pedal position sensor.

DSTC Switch

Volvo gives the customer an option to turn their traction control on and off. There it is, right below the climate control, right next to the side view mirror folding switch (if so equipped).

These switches are rarely replaced (maybe because they're rarely used); that's probably why some later Volvos deleted this switch.

When testing the traction control system on a Volvo, the best tool is still Volvo's VIDA software program. You can hook up your VIDA-equipped laptop, go to the Vehicle Communication tab and click on BCM and select up to ten parameters to monitor. You can have someone drive the car while you watch the numbers for any glitches, or you can you can use your DICE tool and your VIDA to record the parameters during a test drive and replay later to spot any problems. ●

VOLVO INTERIOR ELECTRICAL SYSTEMS

Volvo interior electrical systems are based on a network with a number of modules. We will talk about different Volvo interior electrical systems, what they do, and how to diagnose them using VIDA. We'll also discuss how to diagnose early models without VIDA.

Sunroof motor above the rear view mirror

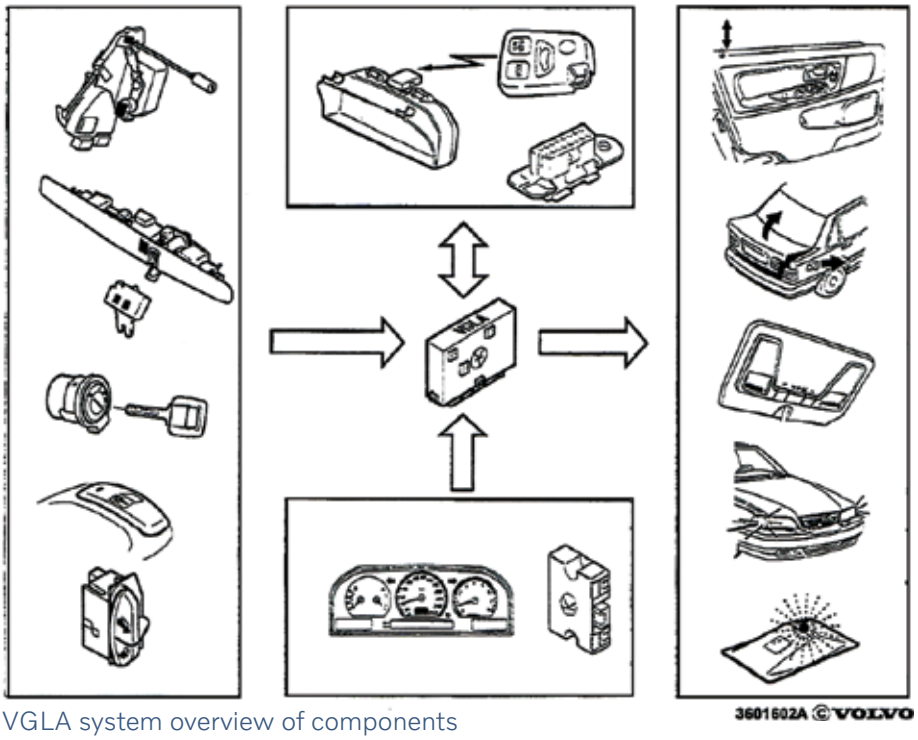
In the 1990s, there were few interior electrical systems. Lights, including dome light, interior lights, instrument panel, electric windows and locks, and alarm systems, and that was about it. These systems were pretty simple and straightforward. Any time there was a problem, the first thing to do was to check the fuses and/or bulbs if one was out. These systems were all 12 volt systems and could be checked out with a test light or volt meter.

These systems from the 1990s were also equipped with relays which also could be a problem. To check these systems without taking everything apart, you could expose the switch and check power and ground to the switch and operate the switch to see if it was working correctly.

Being able to read a wiring diagram and use a meter is a definite plus for locating and repairing electrical problems in older Volvo vehicles and even now in the present.

With the help of VIDA, locating components, reading out codes, and activating components will help in diagnosing problems with interior equipment.

Let's talk about the Volvo Guard Lock and Alarm system (VGLA) in the 1998 to 2000 S70s and V70s. This system has a control module that is equipped with software and hardware to control the lock system and alarm functions. The system is also integrated into the lighting system in the vehicle.



VGLA system overview of components

This control module could be changed to add and remove vehicle keys and remotes that would match the vehicle's VIN.

There are different VGLA designs:

- Central locking system and alarm
  - Central locking is standard in all these vehicles.
  - The alarm system is optional depending on the market.
  - The different markets determine which functions and components are installed in each vehicle. The alarm can be activated or deactivated using the remote or the key.

- Remote Control
  - A remote control is standard on all vehicles with alarm systems. In vehicles with only central locking, the remote control is optional.
  - The remote control receiver works on different frequencies. The remote control works up to 15 to 30 feet. Separate buttons can lock and unlock the doors and the trunk or tailgate in the vehicle. Some remotes have a panic button that will set off the alarm when pushed.

- Type of locking systems
  - There are two different locking systems – a one-stage system and a two-stage system. These systems may be programmed either way.

- Internal switches
  - There are switches in the doors and trunk or tailgate for locking and unlocking this system.
  - There is a switch in the driver's door to unlock the trunk or tailgate and the fuel door latch.

Component Input Signals

- Door switches signal if doors are open or closed.
- Lock switch in driver's door. The locking latch has a micro switch built in and is operated by the key lock cylinder. Locking and unlocking request comes from the central locking system.
- The trunk or tailgate utilizes the same kind of micro switch for locking and unlocking.
- The ignition switch signals if the key is in the lock or

The alarm module or siren is located under the inner fender at the passenger side front

Sunroof button pushed to tilt the back of the sunroof open

not. This would be the S connection at the switch. The signal if the ignition is on or off is the +15 connection at the switch.

- There is an internal switch in the fuel door latch to open the fuel door.
- The speedometer prevents the trunk from coming open when activating the switch at over three mph.

Component Two-way Signal

- The receiver has a built-in antenna and is mounted on top of the instrument cluster for good reception.

Drains and sunroof gates

The receiver receives control signals from the VGLA control module:

- Sends a signal to the VGLA for the remote control
- Changes the radio signal to a digital signal from the remote control to the VGLA control module
- The remote has a unique code for each button.

This control module sends signals to locking motors in the doors and trunk or tailgate. Depending on the locking system, the control module transmits different signals to the central locking motors. The signal can lock or unlock each door and trunk or tailgate.

Alarm Module

- Vehicles with alarms have remote controls to arm and disarm the alarm system. This system monitors the doors, trunk and/or tailgate, hood, and horn or siren.

Component Input Signals

- Hood switch, a micro switch inside the lock mechanism
- Glass break sensor, by the glove compartment near the speaker
- Level sensor, in case vehicle is being towed away
- Metal wire sensor in rear window. In case it is broken the alarm will sound.

The sunroof has been used in Volvos for many years, and the systems have changed from the old mechanical crank system to the new power laminated panoramic roof.

Sunroofs can be quite complicated in troubleshooting and repairing. Having two sides with gates and cables, they must be synchronized so that the roof mechanism

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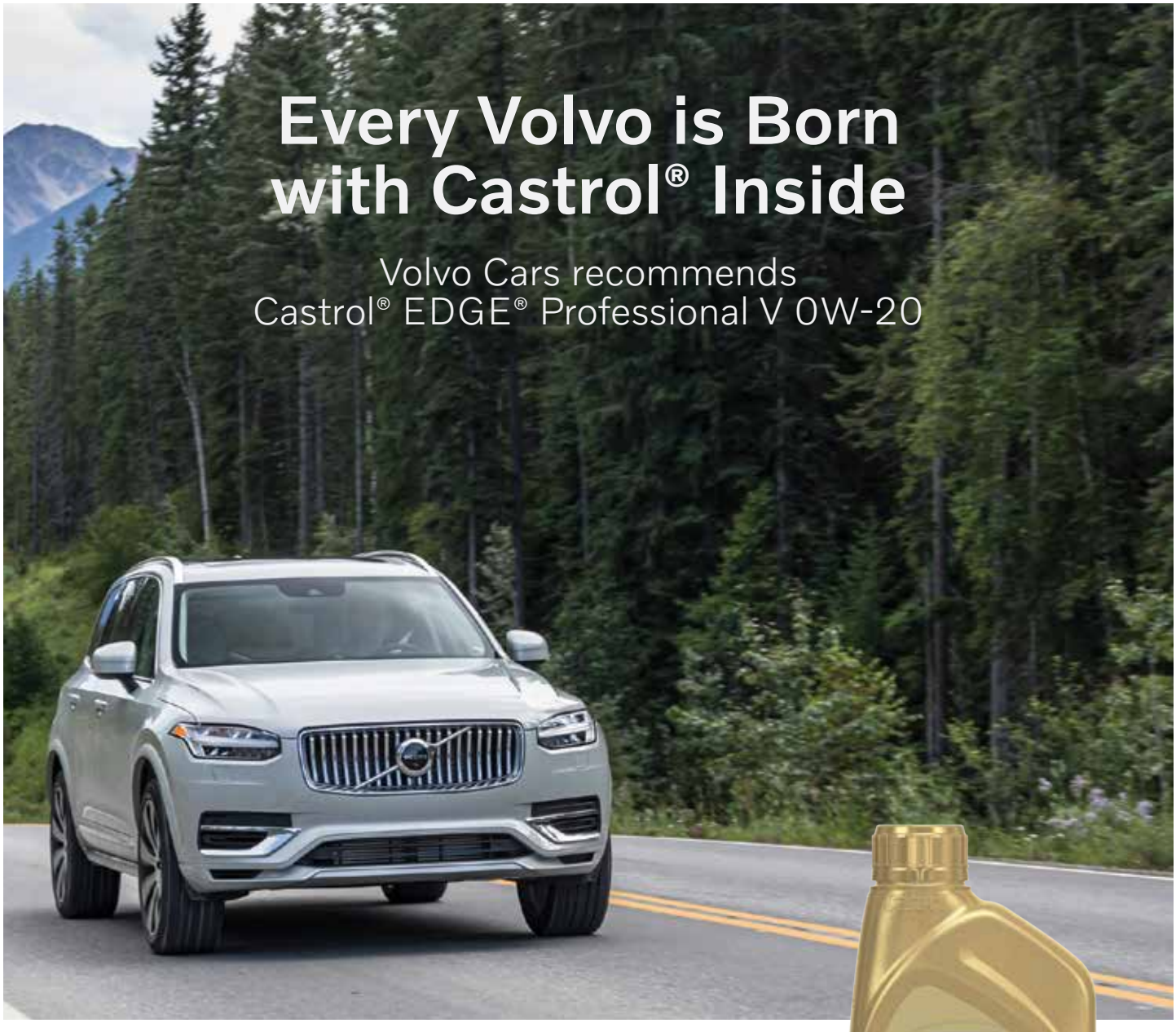

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will move smoothly and all positions work correctly.

When sunroofs became electric, the sunroof motor was located above the rear view mirror. It was mounted with the gear side inserted into the two cables that would open and close the sunroof.

The button that controls the sunroof is located in the dash for the older models and in the dome light assembly on the newer models. Pushing the button back will open the sunroof. Pushing the button the other way will close the sunroof. Pushing the button up will tilt the back of the sunroof open.

Usually the problem with sunroofs not opening correctly is cables that wear out and become flat. When this happens, the motor can jump some teeth, making the sunroof off center. Replacing the sunroof cables and gates can fix this problem.

To replace the cables and gates takes some time, and sometimes you will need to take the complete sunroof tray out of the vehicle to repair it. This means taking out the headliner. This can be quite tricky, so it's a good idea to use VIDA to understand how to accomplish this task.

Laminated panoramic sunroof and front wind deflector

Power seat control on the side of the driver's seat

Maintaining the sunroof is key to making it work properly all the time. Blowing out all the debris while the sunroof is open and cleaning out the drains will help in maintaining a good working sunroof. Lubricating the sunroof gates and tracks with a dry lube works well.

The newer model power laminated panoramic roof is a glass roof divided into two sections. The front section is opened by sliding up and over the rear section that is stabilized. The front section can also tilt up at the rear edge for ventilation. There is also an electrically controlled roller sunshade between the laminated panoramic roof and the headlining made from perforated fabric.

The basic function is quite similar to other Volvo sunroofs. The switch is located in the upper roof panel. The motor opens and closes the roof with cables and gates.

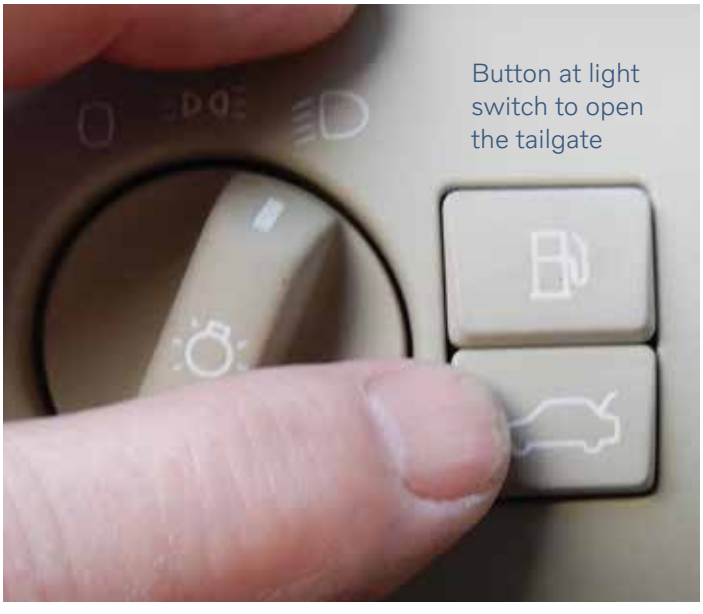
The sunroof has a sunshade that's mounted at the back of the sunroof tray. The sunshade is also operated by the switch and can be opened to any position.

The laminated panoramic roof has a pinch protection system that reduces the risk of closing on a small object or possibly your hand. The system works when anything is blocking the movement of the roof or shade.

A wind deflector at the front of the sunroof pops up when sunroof is opened and back down when closed. The wind deflector helps guide air into the cabin and also helps to reduce noise.

The Power Seat Memory and Function

Volvo has been using power seats since the 1980s. Power seats basically move the seat into position for any driver. The memory function adjusts the seat for different drivers. Each driver can press one of the memory buttons that is programmed for them to adjust the seat to fit them.



Meter used to check electrical connections

The power seats can be adjusted when the key is in position 1 or 2.

During a ten-minute period after the doors have been unlocked, if the door remains open and if the door is closed and the ignition key is not yet in the ignition, or if key is in the ignition but still in position 0, the seat can be adjusted within forty seconds. The passenger seat can only be adjusted if the ignition is in position 1 or 2 or the vehicle is running.

The power seats do have an override protection system that senses anything blocking the seats' operation. If this happens, turn the ignition off and wait twenty seconds before operating the seat again.

Depending on the model and year, there are three different memory buttons to program the seat. To program the seat, adjust it to the desired position. Press down the memory button, and while holding the button down, hold down position 1, 2, or 3. To move the seat to the desired position, push the appropriate number and hold it down until the seat is in position. If you let off the button, the seat will stop.

The remote control can also be equipped with an option function that controls the driver's seat. After you have adjusted the seat to the desired position and turn off vehicle, lock it using the remote control. When you return and unlock the car, the driver's door seat will automatically adjust to the preferred position. If there is more than one remote, depending which remote is used, the seat will adjust to that remote's setting.

Hydraulic Power Tailgate

The 2008 to 2010 V70 and XC70 could be equipped with a hydraulic power tailgate. To open the tailgate, there are three options. One, by pressing the button on the remote control and holding it for 1.5 seconds. Two, by pressing the button inside the cabin located in the light switch assembly and holding it for 1.5 seconds. Or three, by pressing the tailgate outer handle if the vehicle is not locked. When the tailgate is open, you can press the button on the tailgate to close the tailgate.

When the tailgate is open, a message will be displayed on the Driver's Information Module (DIM), and the rear interior light will be on with the rear position lights. The tailgate cannot be opened or closed while the vehicle is in motion.

The power tailgate consists of these components:

- The inner switch located at the light switch
- The anti-pinch sensors located at the track of the tailgate
- The open and close motor located inside the tailgate
- The closing switch located in the tailgate
- The fully open sensor located in the opening motor; the first locking position sensor, located in the opening motor; the load sensor located at the hydraulic pump
- The outside switch located in the handle
- The control module and hydraulic pump, located in the tailgate
- The remote control.

The power tailgate consists of a hydraulic pressure system, which opens and closes the tailgate, and two electric motors — one for releasing the tailgate before opening and one for latching the tailgate.

When opening the tailgate, an electric motor releases the tailgate latch to enable hydraulic opening. Hydraulic oil is then pumped from the reservoir to the hydraulic pump to open the tailgate. Closing the tailgate, hydraulic oil is pumped from the reservoir to the pump and the tailgate retracts.

When the sensor determines the tailgate is at the latch, an electric motor then pulls the tailgate to a latched position assisted by a cable. When the sensor indicates the tailgate is latched, the electric motor is reversed to reset the position of the cable to prepare for the next opening of the tailgate.

Fault Tracing Common Electrical Circuit Problems

Check for open circuits. An open circuit is a break in the path of current flow. In a parallel circuit, a break in the circuit will result in a fault in a particular component. An open circuit in a series of circuits will cause the complete circuit to malfunction. Always check connections for oxidation or possible loose connections. You can use a volt meter to check wire connections. Disconnect connectors and check resistance by pulling or shaking wires. The ohmmeter should read approximately zero.

A short circuit to ground is usually broken or frayed wire insulation. The wire could touch ground and make a fuse blow. Using a circuit breaker tool in place of a fuse can help so you don't keep blowing fuses.

Disconnect each component in the circuit and check for the circuit breaker to pop. If the circuit breaker doesn't pop, it's quite likely that the component that was disconnected could be the problem. After locating the problem, make sure to remove the circuit breaker and replace the fuse. Check to make sure everything works correctly.

A short circuit to supply voltage occurs when wires are frayed or broken and interrupts another circuit. This can cause both circuits to work intermittently or incorrectly. First look at the circuit not operating correctly, and try to identify the problem. Being able to use and read a wiring diagram and learning how the circuit should operate is key to finding the problem.

Check for high circuit resistance conditions. Checking the voltage drop in a circuit will check for high resistance when the circuit is operating. Voltage drop is the amount of voltage required to push the current through a specific resistance. By placing the meter leads at each end of the resistance, you can measure the voltage drop caused by that resistance.

For instance, measure the voltage drop in the positive battery cable that looks to have corrosion at one end of the cable. You can measure the voltage drop caused by the resistance. As the resistance increases, voltage drop increases.

Below are a few terminal designations on a Volvo with standard labeling. ●

1	Ignition coil, ignition distributor negative side
15 (15R)	Switched battery positive, power in key positions 2 and 3
15i	Switched battery positive, power in key position 2
30	Direct battery positive
31	Ground
50	Starter solenoid fee
85	Actuator winding of a relay, usually ground
86	Actuator winding of a relay, usually supplied with voltage
87	Activated output of a relay (87A = second output)
B+	Battery positive
D+/61	Alternator or generator charging light
X	Accessory feed, power in key position 1 and 2

VOLVO

Collision Advantage

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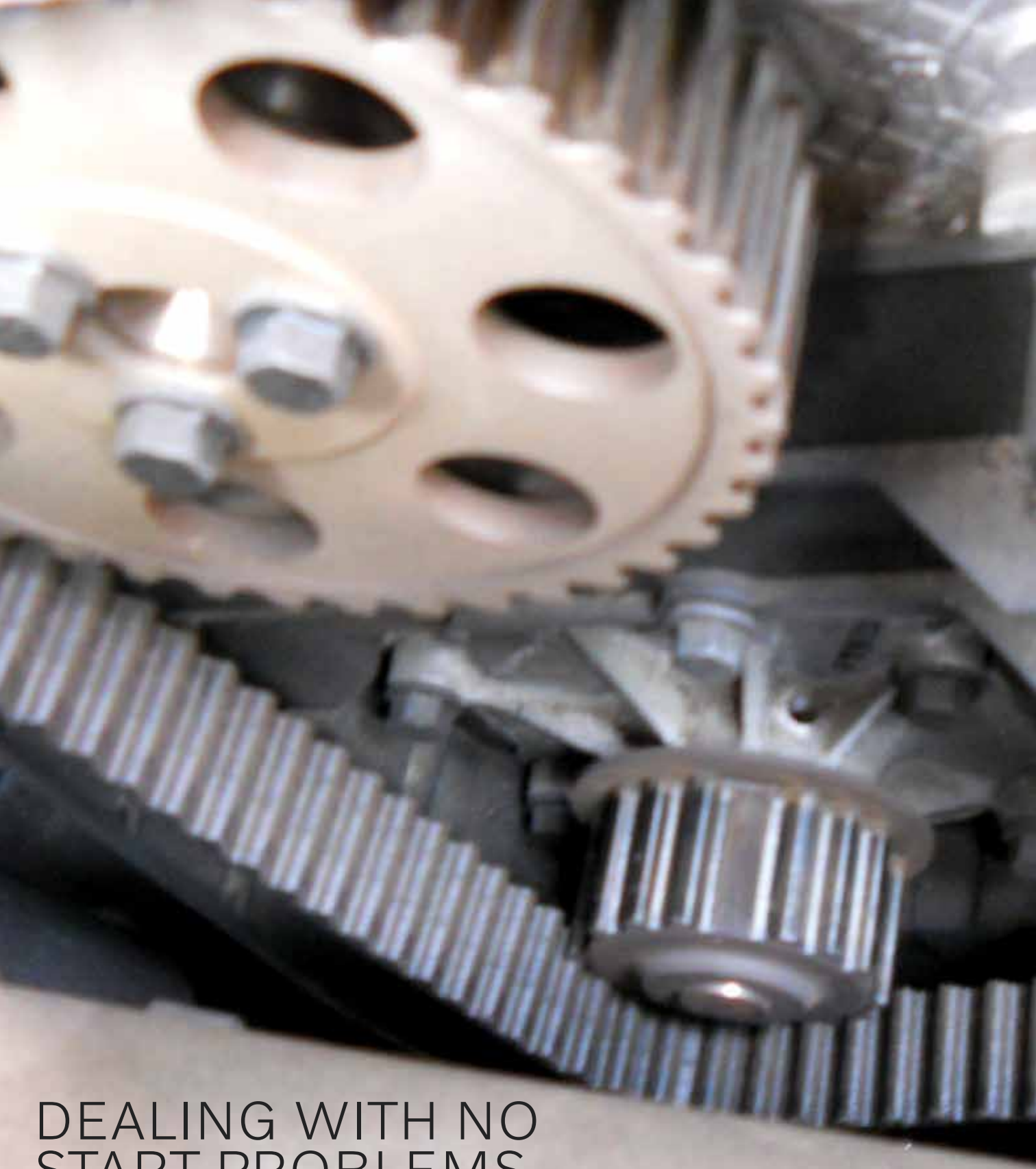


DEALING WITH NO START PROBLEMS ON VOLVOS, PART 1

Volvo is one of those brands that rarely sees the tow truck.

Volvos tend to be able to limp into the shop in most cases, unless the battery is dead or the owner has been severely neglecting the regular maintenance.

When it comes to Volvo, the majority of no start complaints will be battery-related. Non battery-related no start conditions on a Volvo are the exception to the rule in most cases. That being said, ALWAYS CHECK THE BATTERY!!

Some of the more common causes for no starts on Volvos are:

- Battery
- Alternator
- The rare starter motor
- Ignition lock sticking
- Immobilizer and key communication problems
- Fuel pumps (more common in pre-2005 models)
- Broken or shorted wiring (commonly caused by rodent activity under the hood)
- Out of gas!
- Camshaft or crankshaft position sensor
- Broken timing belt (ouch!)

These are just a few, and most of these issues are fairly easy to diagnose — that's if the car has a solid symptom when the car is towed in.

Of course, starting issues can come in a wide variety of flavors; the majority that we see come into our shops today are of the intermittent variety.

The word "intermittent" can strike fear into the hearts of a lot of technicians, but with training and experience that word will become less daunting.

When a customer comes into your shop and says, "My car doesn't start," or some version of that, the first step should always be a detailed customer interview. This is especially critical in the case of an intermittent symptom or symptoms.

If the person that brings the car in is not the person that drives the car, it is important to try to interview the person who does. This will help avoid confusion and misleading information about the problem.

Ask the right questions. The average customer will not be able to accurately describe all the symptoms, especially if the problem only happens once a year on a cold Tuesday at noon.

What are the right questions?

It depends on the problem. If the car comes in on a tow truck with a solid no start condition, the list of questions can be shorter than in the case of an intermittent issue.

If your service writer is not that technical, it will help if a technician asks the questions. If that is not possible, your shop can develop a symptom form that the customer can check boxes on.

Questions like: Where, when and how often are just the beginning. The right kind of customer interview process will save a lot of time, confusion and money.

Here is one case where a good customer interview process would have come in handy.

Has this ever happened to you?

A 2000 Volvo XC70 got towed into the shop one day with a crank but no start condition. The customer said the car just stalled out. The technician started his testing with the basics; he checked for spark and checked for fuel pressure. There were both. The tech then hooked up his scan tool and checked for stored codes. Again nothing. The tech then checked the live data while cranking, and still no joy.

After a few hours of hair pulling, the tech went and asked one of the other techs what they thought. The other tech asked, "Is it out of gas?" The tech that was working on the car said, "Of course not. I checked the fuel pressure, plus the gauge reads a quarter full."

Q: Is it possible to have fuel pressure and no fuel volume?

A: Yes.

So the other tech walks over to the car that was up on the lift and taps on the gas tank. Of course the tank sounds empty.

They add some gas and voila, the car starts.

The service writer calls the customer and asks, "Does your fuel gauge work?" The customer then says, "Nah, it's been broken for years."

Could the right questions have helped save all that wasted time?

ASK THE RIGHT QUESTIONS!

In the case of "very" intermittent customer complaints, like the type that only occur every other month or so, you would probably have a better chance of winning the lottery than experiencing the symptoms while the car is in your shop. In a lot of these cases, there will be no stored data or codes to work with. And if you don't experience a symptom, how can you know you fixed the problem?

It's up to you to educate your customer on how difficult it can be to pinpoint a very intermittent no

start condition. When it comes to no start and other diagnostics, have a game plan and a standard step-by-step procedure.

If you follow the same systematic way you diagnose problems, especially intermittent ones, you will become better and faster at finding the root causes.

Part Number	Description	Comments	Size (kB)	Download Time (min)
30677016	CCM upgrade		178	1
30677017	CEM upgrade		308	1
30677018	DDM upgrade		60	4
30677021	ECM gasoline upgrade		741	1
30785453	ETM/ECM p upgrade		741	1
30677027	PDM upgrade		57	4
30677030	REM upgrade		53	—
8691415	Service 2.0 upgrade		389	—
30677038	Total upgrade CAN		1782	14

Check those TSBs, or, as Volvo calls them, Technical Journals (TJs or RTJs). Volvo has issued several that deal with starting problems across all their years and models. Some of the starting issues that are covered in these bulletins may surprise you.

One example is RTJ 21487; this bulletin only covers a problem with one production year — 2010. The problem that is covered is a no start caused by the key fob not being recognized due to electromagnetic interference caused by a chrome plated lock bezel.

Information is probably the greatest tool in the modern auto technician's arsenal. Luckily for us, all that valuable info is at our fingertips on the web. If you want the most up-to-date repair and service information on Volvos, the best site is volvotechinfo.com, and the best tool for the job is Volvo's VIDA software.

When checking or charging the battery on a Volvo, it's best to hook up at the battery; don't just hook up at the remote B+ at the fuse box; these connections are designed to be used for jump starting only.

Don't Forget to Check the Basics

As these cars have become more and more complex, so have our testing tools and procedures.

If you perform a lot of diagnostic work at your shop, you are not alone; now and into the future advanced diagnostics will become more a way of life for us. Your shop needs to keep up with new technology through continued training and investment in new tools and equipment.

CHECK THAT BATTERY!

The rules have changed. In the old days, the good old 12 volt battery only had to perform a few basic jobs, including turning the starter and storing power.

Of course we all know that, but did you know how sensitive the modern CAN network cars are to 12 VDC battery's condition, capacity, and state of charge?

In the old days the average battery could last 5 to 10 years or more in rare cases. Today's cars demand so much from their battery that the average lifespan of the 12 volt battery in the U.S. is 3.5 years, and that's in normal conditions.

VOLVO

Cabin Filter

CLEAN AIR FOR EVERYONE

All Volvos are equipped with a cabin filter that cleans the incoming air to ensure a healthy in-car environment.

Replace the cabin filter every other maintenance visit, or more frequently if driving in high traffic areas or on dusty roads.

Contact your local Volvo dealer for a complete selection of Volvo Genuine Parts.

When it comes to Volvo batteries, the same rules apply.

The rules have changed when it comes to testing and charging batteries too. Like everything in life there is a right way and a wrong way. Don't just roll the old VAT 40 over and crank the knob to full until you see the smoke.

To perform an accurate battery test on a modern Volvo you need to access the battery posts and use a modern battery testing system. Some lazy techs think that they can test the battery from the positive post connector in the main fuse box...

DON'T DO THIS!

Your shop should have a modern battery testing system, especially when checking AGM (Absorbed Glass Mat) batteries.

If you don't have a newer style battery testing tool, it's time to get one; this goes for your battery charger too.

There are two Volvo-approved methods for testing when addressing a customer concern regarding the 12 volt battery: The VIDA Battery Test and the hand-held batter tester 9513030 (Midtronics BT3300). These testers are very accurate if used correctly and also have the ability to test the starter and charging voltages. And they have the ability to print out the results of the test so you can show the customer.

You should always perform a battery and charging system test with the battery fully charged if possible. Of course, if the battery will not take a charge, that's where you should start.

Tools of the Trade

What tools do you go for when diagnosing a no start condition?

That all depends on what type of no start you are dealing with. Is the symptom consistent or intermittent? And how intermittent?

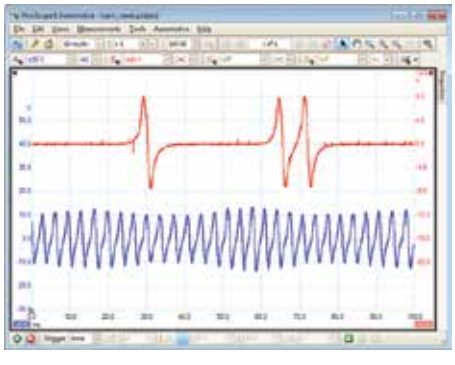
Of course in any no start diagnosis, tools should include a scan tool such as Volvo's VIDA, a battery tester, and a fuel pressure gauge. But you may have your own favorite tools to help you get to the bottom of these types of problems.

Some old tools are becoming popular again for diagnosis of difficult-to-find issues. Four-channel oscilloscopes can be very useful in the hunt for intermittent problems and can be used to compare waveform patterns to verify the function of multiple systems and components.

And some new tools that were not designed specifically for automotive repair can be very useful. Some technicians are experimenting with tools like the FLIR (Forward Looking InfraRed) gun. This very cool tool can be used for checking multiple systems and issues on cars.

One of the more interesting ways to use this tool is to help find a key-off parasitic battery draw. The way to do this test is to let the vehicle that you are testing, for

If your shop is still using the old VAT 40 for all your battery testing, it's time to invest in a new charging system testing tool.



Old tools are new again; a lot of shops are bringing back the oscilloscope. The modern four channel scopes can do a lot more than the old ones ever could.

There are many ways to use this tool to diagnose problems and confirm the repairs. These tools take some training and real time experience to master but the results are worth it.

key-off drain, sit in the shop overnight, so the whole car is at ambient temperature. You can then use the FLIR gun to scan around the vehicle to see if there is an area that is warmer than the rest of the car. The area that is warm is usually the area that is energized and drawing amperage.

This test can be very effective in the fuse box area.

NOTE: A FLIR gun can help point out an affected circuit, but you should always confirm the fault by performing the appropriate testing.

New tools like the FLIR gun can be effective in helping to pinpoint circuits that are drawing power when they're not supposed to.

It can be easy to forget to check the basics and jump down the diagnostic rabbit hole.

The Smoking Gun — A Case Study: 2008 Volvo XC90 3.2L Towed in With a Crank But No Start Condition

In some cases, diagnosing a no start condition can be relatively simple. In the case of this XC90, the customer reported that when the car was started in the morning, smoke started coming out from under the hood, and the car stalled and would not restart.

The customer, of course, thought the worst and was expecting the shop to tell him that the engine blew up or something like that. After a quick check of the oil and coolant levels by the technician, it was apparent that such was not the case. The tech confirmed that the engine did crank normally but would not start.

The tech then hooked up the car to a laptop equipped with Volvo's VIDA software and checked for live data and stored codes.

The codes that were related to the no start were ECM P0302 and ECM P035211. The tech then removed the cover on top of the engine to inspect the ignition coils and there it was – literally - "the smoking gun."

The number 2 coil had internally shorted out and blown the fuse for the ignition system.

It's common for higher mileage Volvos to have coil failures, but to have one melt down is a lot less common.

NOTE: If you have a higher mileage Volvo in the shop with one or more failing ignition coils, you should always recommend that the customer replace all the coils at the same time. This will help avoid a comeback

Sometimes you get lucky and a no start tow in turns out to be an easy diagnosis. In the case of this shorted ignition coil, there was a smoking gun, literally.

due to the fact that all the coils are the same age and have the same mileage on them. A new set of genuine Volvo spark plugs would be a good idea too.

The point is, that with changing technology and older Volvos on the road, we are going to see issues in the shop that even the most experienced Volvo technicians may be surprised by.

RATS!!

Yes folks, they and all their little rodent friends love nothing better than to crawl up into a warm, cozy engine compartment for the night, and not only do they get a warm bed but there's an all-you-can-eat buffet included.

If you get a Volvo in your shop with mysterious electrical problems, make sure to inspect the engine compartment for signs of rodents. If you see a lot of droppings and debris, you should ask the customer if the car is parked for long periods in places like forest areas, barns, or garages with known rat activity. Rats love hoses and wire insulation.

Is the Network Awake?

Some early Volvos from 1999-2001 with CAN bus networks can experience a no start condition if the battery voltage drops below 9 VDC because some of the network nodes have gone to sleep and need to be awakened, and replacing or charging the battery won't always do the job.

There are two common ways to do this. The best way is to use Volvo's VIDA software program to ping the nodes that are offline. When you are in VIDA, go to the Network tab; the modules that are offline are in gray. If you can't wake them up with VIDA, you can go to the next step.

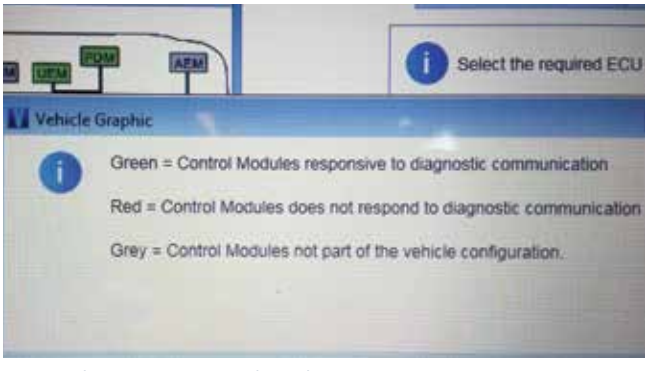
You can disconnect the positive and negative battery terminals and short them together for 15 to 30 minutes.

When replacing spark plugs on a Volvo, the only reliable choice is to use genuine Volvo plugs.

This should clear the memory out of all the modules and reset the adaptions to factory default settings.

And if a module such as the ECM has gone into some sort of limp mode, this should clear that too. ●

If the car you are working on has intermittent electrical problems and you see evidence of rodent activity, make sure to inspect the wire harness carefully. Rats love the taste of wire insulation.



On early CAN network Volvos, you may get a car towed in with a crank but no start condition caused by the battery voltage dropping below 9.5 VDC. This can cause some of the modules to go to sleep, so when you check the network with VIDA the modules that are off line are in red or gray.

Keep the Work Flowing

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VOLVO

UNNECESSARY BRAKE CONTROL MODULE (BCM) REPLACEMENTS

No: TJ 12913
Func Group: 5931
Partner: 3 US 7510 Volvo Cars North America
Issue Date: May 14, 2010

Customer Symptom Codes (CSC)

Code	Description
CP	Warning lights and chimes/Anti-lock Brake System (ABS) indication/no indication
DE	Warning lights and chimes/Brake failure indication/no indication
DY	Warning lights and chimes/Antispin/antiskid (DSA, TRACS, STC, DSTC) indication/no indication

NOTE:

This document supersedes retailer technical journal 16701, dated 07-14-2008. More vehicle types have been added to the header. RTJ 16701 will be deleted. Please update your files.

Description:

When diagnosing Diagnostic Trouble Codes (DTCs) for the Brake Control System, a technician must always follow the complete diagnostic fault-tracing path in VIDA. VIDA always lists the "Possible Sources" of the fault. In cases where the Brake Control Module (BCM) is NOT listed as a possible source, VIDA has added this note:

"Note! This diagnostic trouble code (DTC) is not due to an internal hardware fault in the Brake Control Module (BCM) and must not be remedied by replacing the control module."

We understand that BCMs are being replaced solely on the appearance of a DTC in this RTJ, without following the diagnostic path in VIDA.

The occurrence of any of the DTCs listed in this TJ is not conclusive proof that the BCM is defective.

Similarly if none of the following DTCs are found, the BCM has no hardware defect, and the BCM must not be replaced. Replacing the BCM without a proper analysis may cause repeat repairs and consequently decreased customer satisfaction.

A workflow chart has been created and should be used as a guideline (additional to VIDA) when diagnosing BCM DTCs. See Figure 1 in the attachment.

Service:

If the BCM is replaced, printed information from VIDA which shows an appropriate DTC is required. Use the 'print' function on the VIDA screen. Note that this printout must show the VIN (which must match the VIN on the warranty claim), the appropriate DTC, and the date, which must be near the QW90 repair date. All three of these requirements are circled in Photo 1 in the attachment.

S60, V70/XC70 MY-07, S80 MY-06, XC90 excluding engine V8 & SI6 (B8444S & B6324S):

The BCM may have a general hardware defect if any of the following conditions is true. Go to VIDA for fault tracing. Check the "Possible source" list. Replace BCM only if proper fault tracing according to VIDA concludes that the BCM is faulty.

- One or more of the following BCM DTCs are set: 0010, 0020, 0030, 0040, 0050, 0052, 0057, 0058, 0065, 0068, 0070, 0071, 0072, 0074, 0103, 0116, 0130, 0133, 0136, 0138, 0139, 0140, 0147, 0151, E000.

Service:

- CEM DTC 1A5F is set.
- More than one of the following BCM DTCs are set: 0094, 0097, 0100, 0115.

In all other cases, the BCM does not have a hardware defect and should not be replaced.

XC90 engine V8 & SI6 (B8444S & B6324S):

The BCM may have a general hardware defect if any of the following conditions are true. Go to VIDA for fault tracing.

Check the "Possible source" list. Replace BCM only if proper fault tracing according to VIDA concludes that the BCM is faulty.

- One or more of the following BCM DTCs are set: C002001, C00201C, C002071, C002201, C003101, C003401, C003701, C003A01, C004401, C004501, C004664, C004801, C004864, C006A01, C008204, C008216, C008217, C008249, C110801, C111301, C111542, C111802, U000100, U012588.
- CEM DTC 1A5F is set.
- More than one of the following BCM DTCs are set: U011400, U030046, U010000, U012600.

In all other cases, the BCM does not have a hardware defect and should not be replaced.

If TMA requests that the BCM be returned, the VIDA printout must be returned with it.

BCMs returned without this printed information, or printouts which do not show applicable VIN and DTCs as indicated above, may result in a warranty claim debit by VCNA.

Workflow When Diagnosing A BCM DTC:

A BCM-related DTC is found in the vehicle.

By reviewing the lists below, determine if the DTC is:
1. Listed in this TJ.
2. Hardware-related problem.
3. Power supply or CAN communication related.

1. The concerned DTC IS NOT listed in this TJ.
   - Do not replace the BCM. Go to VIDA for fault tracing.

2. The concerned DTC IS listed as a hardware issue in this TJ.
   - Go to VIDA for fault tracing. Check the "Possible source" list.
   - Replace the BCM only if proper fault tracing according to VIDA concludes that the BCM is faulty.

3. The concerned DTC IS listed as a power supply or communication issue in this TJ.
   - By using the BCM breakout box:
     A. Check that BCM has power supply coming from the CEM.
     B. Check the BCM grounding.
   - By following the instructions in VIDA, make sure the CAN network is working properly.
   - By using VIDA, make sure that the BCM is communicating on CAN.
   - Replace the BCM only if the power supply and CAN connections are OK and BCM is not communicating on CAN.

VOLVO 5 CYLINDER ENGINE VALVE COVER SEALING

The Volvo 5 cylinder engine has been the workhorse engine for many years, starting in 1993 with the 850 model in the U.S. The 850 went away in 1997 with the introduction of the S70 and V70 in 1998 and the XC70 in 1999.

Timing marks aligned in the correct location

Volvo continued using this 5 cylinder engine until 2014 in the S60, and they then went back to the 4 cylinder engines. This article will address sealing the valve cover on the 5 cylinder engine, what to look for, and what tools to use to make this job complete.

The 5 cylinder engine started with the Volvo 850. This model was pretty simple with two mounted sprockets at the front camshafts, no Variable Valve Timing (VVT) units, and no solenoids or coil packs. Basic spark plug wires and distributor cap that could be set aside make this model a little easier on which to seal the valve cover.

As the engine changed through the years, adding coil packs to each cylinder, VVT units and VVT solenoids with electrical connectors made for a little more involvement to reseal the valve cover.

Special Volvo tools are needed for this job — 9995452 is the tool for the rear of the camshafts. This tool will keep the camshafts aligned properly. 9995454 is the tool used to press down the valve cover. It is used by removing the spark plugs from cylinders 1 and 5 and screwing the tool into the spark plug holes.

As the years go by, the valve cover will start to leak and will need to be sealed again. One cause of valve cover leakage is the oil trap which gets clogged up and the engine cannot breathe. In turn, pressure builds up inside the engine and pushes the oil out in its most vulnerable spot, which sometimes is the valve cover and/or cam seals.

Make sure the oil trap and all hoses are free of clogged debris. Make sure to check the pressure in the engine and, if the oil trap is plugged, be sure to replace it and clean out the passages into engine. Proper maintenance, including changing the oil when it's time, can help prevent build-up inside the engine and will make the vehicle last longer.

These valve covers don't have a regular gasket but rather have a chemical gasket that is used to bond the valve cover to the cylinder head once everything is bolted together.

Through the years a few things have changed with this engine, but doing this job is primarily the same with all of the 5 cylinder engines.

Tool 9995670 is used to lift the valve cover from the cylinder head. Tool 9995451 is the crankshaft stop tool. Volvo tool 9512767 is a roller to apply liquid gasket during assembly. 9995450 is the press tool for the rear camshaft seal. 9995718 and 9995719 are special tools to press in the camshaft seal at the front of the engine.

After confirming an oil leak at the valve cover, now it's time to disassemble. Disconnect the battery and drain the coolant from the vehicle. Disconnect the small hose at the expansion tank and lift up the expansion

Top view of 5 cylinder Volvo engine

tank while removing the connector for the level sensor. Disconnect the big hose and remove the expansion tank from the vehicle.

Lift the power steering reservoir up and over the valve cover and let sit until the timing belt assembly is removed. Remove the auxiliary belt. Remove the front engine cover from the engine and set aside. Remove the front right tire and remove the nuts that hold the inner fender in place to expose the crankshaft nut. Spin the engine over at the crankshaft until the timing marks are aligned properly.

Remove the air cleaner assembly by disconnecting the hose clamp at the air mass meter and disconnecting the air inlet hose. Some models will have the turbo boost valve connected to the air cleaner housing, so this will need to be disconnected also. Now pull up on the housing and remove it from the vehicle. Remove the top stabilizer brace that is mounted at the strut towers.

The hose that was just disconnected at the air mass meter, you can now disconnect it at the turbo and remove the other connecting hoses and electrical connectors. Remove them from the vehicle and set aside.

The hard turbo pipe from the intercooler to the top of the turbo will need to be removed. Make sure to check to see if the intercooler hose is oil soaked and, if so, replace it during reassembly.

Remove the plastic cover over the spark plugs. Remove all coils over the spark plugs and number them so you can remember their location during reassembly.

Disconnect the ground wires and, with the coils still connected to the electrical connectors, pull the coils off and set them onto the transmission out of the way. Remove the wire connector at the VVT solenoid. The crankcase ventilation hose will need to be disconnected at the top of the valve cover.

Remove the cover from over the injectors. This cover may be plastic or metal depending on the year of the vehicle. Remove the two 10 mm bolts that hold down injector rails and pull the injector rail straight up and set it out of the way. This will give room to seal the valve cover.

Remove the top engine mount and cam sensor housings from the rear of the engine at the back of the camshafts. This will expose the rear of camshafts so you can install special tool number 9995452.

Remove the front cam sprockets and VVT unit bolts with a Torx T55 tool. Use a rag when removing the center bolt at the VVT unit to absorb oil coming out of the unit.

Now that the VVT bolts are loose, unbolt the timing belt tensioner and remove the timing belt. Now remove the front sprockets and VVT unit, if equipped, and set aside. Before removing the VVT unit check for lateral play; if there is any, be sure to replace the unit with a genuine Volvo part.

Remove the VVT solenoids, depending on year and model. Install the special tool in number 1 and 5 cylinders, tool number 9995454. Tighten down and leave about a 2-3 mm gap at the valve cover.

Remove all bolts securing the valve cover to the cylinder head. Once all bolts are removed, use the

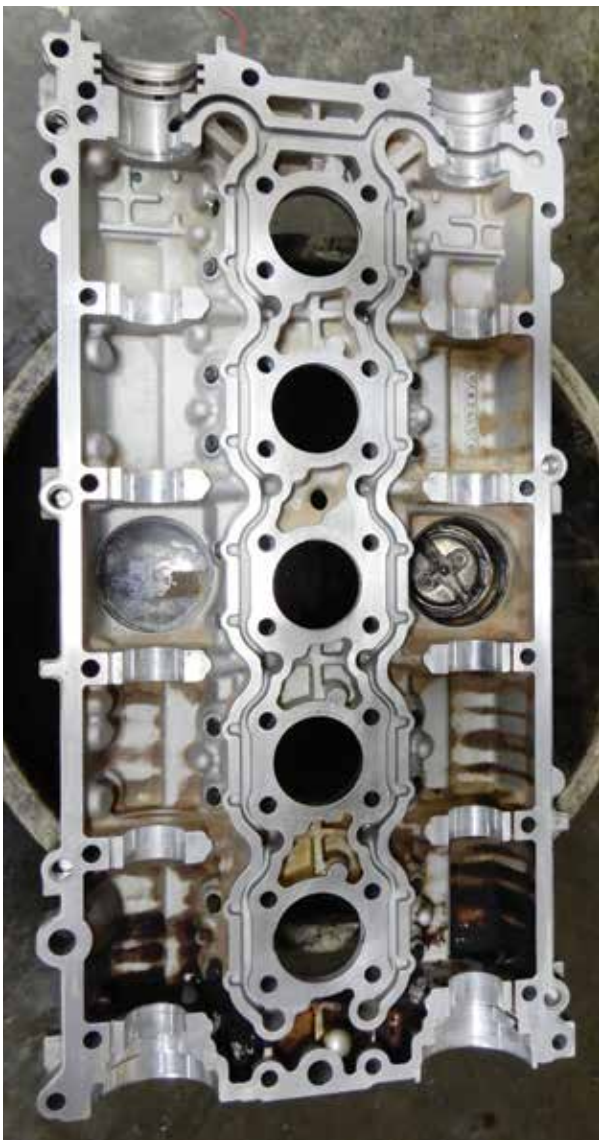
Tool installed at rear of camshafts

Using special tool 9995670 pliers to remove valve cover

special tool pliers to break loose the valve cover from the head. Apply pliers around the valve cover in different locations, and slacken off the wing nuts on special tool 9995454, little by little, until the valve cover is separated from the cylinder head.

Remove the valve cover with camshafts, and set the camshafts aside. Inspect all parts and camshafts for any problems.

Now clean all parts, including bolts and nuts, for reassembly. Use a gasket scraper and/or razor blade with solvent, part number 1161440, to clean off the valve cover and the cylinder head. Clean all debris from the cylinder head and blow it out with air to get all particles removed. Using a spray solvent works well. Be sure to clean in a well ventilated area and try to not breathe fumes.



Valve cover after cleaning and ready to assemble

Make sure to check all bolt hole threads in the cylinder head. Being aluminum, the threads can sometimes pull out with the bolt during disassembly. In this case, you may be able to save the threads with a thread chasing tap, and if no threads are left, you will have to install a threaded insert.

Now that the cylinder head and valve cover are cleaned and ready to be assembled, make sure all lifters are in place and clean. Since we didn't replace the cylinder head, the valve adjustment will be fine. Lubricate the valve lifters keeping the surface for the valve cover clean.

Set the exhaust camshaft into place on the cylinder head with the back of the camshaft below an imaginary center line. Set the intake camshaft into place with the back of camshaft above an imaginary center line. Setting the camshafts in with tool 9995452 attached to the rear of the camshafts will also work when installing the camshafts.

Install new o-rings at the spark plug wells on the cylinder head, making sure to set them in the grooves. Now, on the valve cover itself, apply liquid gasket Volvo part number 1161059. Using roller special tool 9512767, apply liquid gasket, making sure the complete valve cover is covered. Be sure not to let the liquid gasket end up in the oil channels.

Lubricate the camshaft lobes, the valve lifters, and bearing surfaces. Set the valve cover into place and install tool 9995454 into spark plug holes 1 and 5. Tighten the press tool down, keeping the valve cover parallel to the cylinder head until flush. Install the valve cover bolts and slightly tighten them down starting from the middle going out. Once all bolts are in, remove the press tool. Using a torque wrench, torque down the valve cover to 17 Nm. Be sure to check year and model; torque could be slightly different.

Install the tool at the back of the camshafts if not already done. This will align the camshafts to be in the top dead center position. Install new front camshaft seals using special tools 9995718 and 9995719. Lubricate the surface on the inside part of the seal that rides on the camshaft. Using the tool, press the seals into place, using the bolts that hold the VVT unit and sprocket in place.

Install new gaskets for the VVT solenoids that sit on top of the valve cover. Install and adjust the VVT unit or units onto the front of the camshafts. Secure the center bolt but don't tighten completely. Install the sprocket gear onto VVT unit, leaving all three bolts loose for now, and try to align the timing marks so that they are within two sprocket cogs or teeth. This can be adjusted and tightened when the belt is installed.

Set the other camshaft up the same way, or just install the sprocket gear with timing marks aligned, again leaving three bolts loose to be tightened after the belt is on. This would be a good time to replace the timing belt and water pump if needed.

Timing belt tensioner in correct position

Apply liquid gasket to the valve cover with a roller.

There’s No Second Chance

VOLVO GENUINE BRAKES

Volvo Genuine Brakes are more than simply replacement discs and pads. They are essential components that interact with sophisticated systems and software to help ensure the safety and performance of Volvo cars.

Installing Volvo Genuine Brakes is an investment in reliability and quality – the best option in the marketplace for keeping your customers safe. Get the replacement brake parts designed and engineered by Volvo.

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Route the timing belt under the crankshaft pulley and up to the intake camshaft sprocket, around the sprocket, and over to exhaust gear VVT variable valve timing unit, around water pump and over to the tensioner. Leave the tensioner loose so as to push the tensioner so that the timing belt can be installed around the tensioner. Use a 6 mm allen wrench to adjust the tensioner into the correct position.

Tighten the front camshaft sprockets and VVT unit(s) to specs. Remove the tool above the starter and install the starter back into place. Connect the electrical wire if disconnected. Remove the special tool at the rear of the camshafts. With a 30 mm socket and ratchet at the front of the crankshaft, turn the engine over a couple of times and make sure the timing marks are aligned perfectly.

Clean the rear camshaft journal with emery cloth so that the seal mating surface is clean of any contaminants. Using special tool number 9995450, lubricate the seal inside surface and press into place.

Clean out the area that injectors sit in and blow out any debris. Set the injector rail into place and push down. Install two bolts at the rail and tighten down.

During this operation, if the oil trap is plugged or hasn't been changed, this is a good time to address. By removing the intake manifold, the oil trap can be exposed.

Install the front timing cover and secure. Install the auxiliary belt and, if needed, replace with new genuine Volvo part. Set the expansion tank into place, connecting both upper and lower hoses. Secure the level sensor in the bottom of the expansion tank. Set the power steering reservoir into place.

On the back side of the engine, install the camshaft sensor housing and sensor. Depending on the year and model, there is a cam plug on some models. Install the top engine mount. Install the spark plugs and torque down. The coils and wires can now be installed in the appropriate positions, marked 1-5. Attach the electrical connectors to the camshaft solenoids and route so as to not get pinched from the cover. Secure the two ground wires. Set the plastic cover over the spark plugs and timing belt and tighten down.

Install the air charge hose going from the turbo to the air mass meter at the air cleaner. Attach the electric connector at the hose. Connect the other hoses in their appropriate places. Install the bracket at the back of the engine that covers the camshaft sensor housing. Connect the camshaft sensor electrical connector if not already done.

Set in the air cleaner box and snap it into place. If the mounts are worn out, be sure to replace them; this will keep the air box from sliding around. Install the air filter and top cover, securing to the air cleaner box. Connect the air charge hose to the air mass meter and tighten the clamp. Connect the air mass meter electrical connector.

Install the turbo pipe from the turbo to the bottom hose at the intercooler and tighten the clamps securely.

Connect the battery terminals. Add coolant to the vehicle and start the engine. Warm the vehicle up, letting all residue burn off the engine. Check the coolant level and top off. Install the top support bar from the strut towers and secure.

Test drive the vehicle and check all fluids again, making sure all are at the correct levels. ●

Camshaft sensor at rear of engine

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